



Canadian Space Agency
Agence spatiale
canadienne



ISS Science Utilization by the Canadian Space Agency

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Space Life Sciences

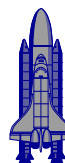
Canada

Canadian Contribution

- Space Station Remote Manipulator System (SSRMS) - Canadarm2
- Mobile Remote Servicer Base System (MBS)
- Special Purpose Dexterous Manipulator (SPDM) - Dextre
- Artificial Vision Unit – 5A March 01
- MSS Operations & Training Facility



6A
SSRMS



UF-2
MBS

SPDM
to
KSC



UF-4
SPDM.



Canadian Space
Agency

April 2001
Agence spatiale
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June 2002

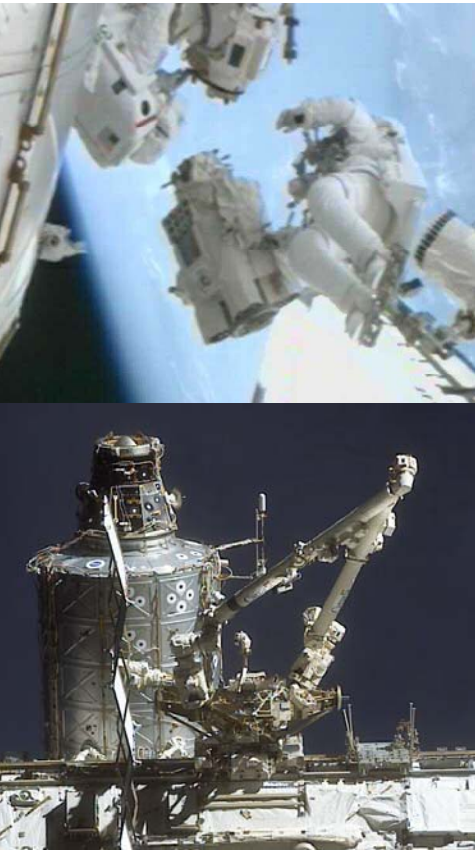
2003

2004 Oct

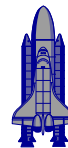
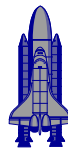
April 2005

Canada

Canadarm2 & MBS



- Green for on-going ISS Support
- Limited Ground Control capability being implemented to reduce crew time requirement for robotics



| | | | | | |
|------|------|----------|-----------|------|------|
| 1999 | 2000 | Apr 2001 | June 2002 | 2003 | 2004 |
|------|------|----------|-----------|------|------|

CSA's Rights to Utilization



- 2.3% of non-Russian utilization capability
- Predicted at Assembly Complete (pre-Bush):
 - Accommodation: pressurized 1 rack
 - Accommodation: external 1 site
 - Resource: crew time 200 hr/yr
 - Resource: energy 6,000 kW-hr/yr
 - Right to purchase: transportation 530 + 190 lb/yr (each way)
 - Right to purchase: communication 30 Tb/yr
- At present, CSA's crew time is 24 hr/yr





Space Science

ISS is used by two Space Science Disciplines:

- Microgravity Sciences
- Space Life Sciences





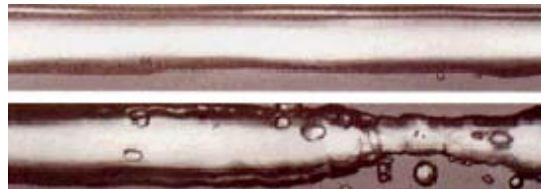
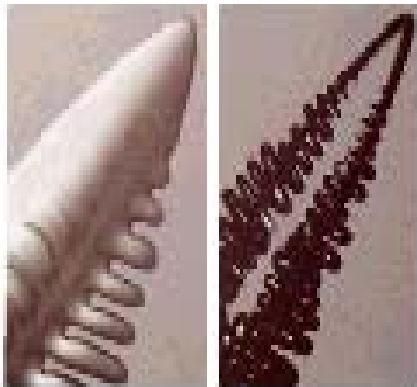
Microgravity Sciences

- In 1986, created the User Development Program;
" to develop an experienced and proficient Canadian Community of Scientists and Engineers to effectively use microgravity environments and facilities, such as the ISS, for Canadian socio-economic and regional benefits"
- In 1994, name change to the Microgravity Sciences Program (MSP)



Microgravity Sciences Program

- Understanding the laws of chemistry and physics in the microgravity of space
- Areas of focus determined in consultation with the Microgravity Sciences Advisory Committee



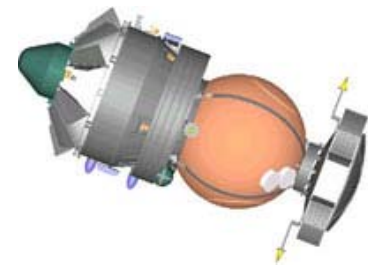
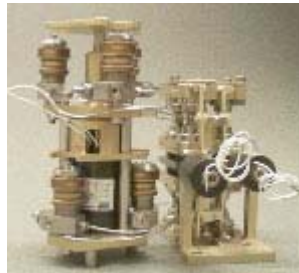
Program Focus

- **Materials Science**
 - solidification, crystal growth, diffusion
- **Fluid and Combustion Science**
 - motion and structure of fluids in response to external forces
- **Biotechnology**
 - structure and behaviour of non-living organic materials

Recent Scientific Missions



- **Protein Crystallization Experiment**
 - Chinese Shenzhou recoverable satellite
 - 16 successfully grown proteins were recovered and are under investigation



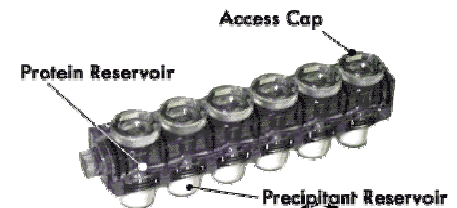
Recent missions

■ Soret Coefficient in Crude Oil

- ESA Foton Mission using Canadian equipment made by C-Core
- Failed on launch

■ STS-107 Protein Crystal Growth Mission

- 144 wells to study 11 proteins
- Experiment lost with Columbia accident





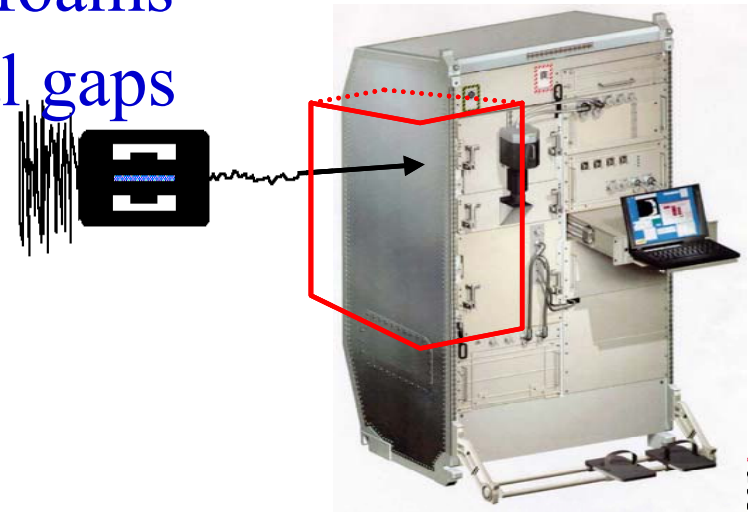
MGS Payloads for ISS

- Vibration Isolation Platform: MIMBU
- Material Science Payload: ATEN furnace
- Protein Crystal Growth Payload: Prospect
- Fluid Science Payload: SURF
- Access to ESA Fluids Science Laboratory (FSL)



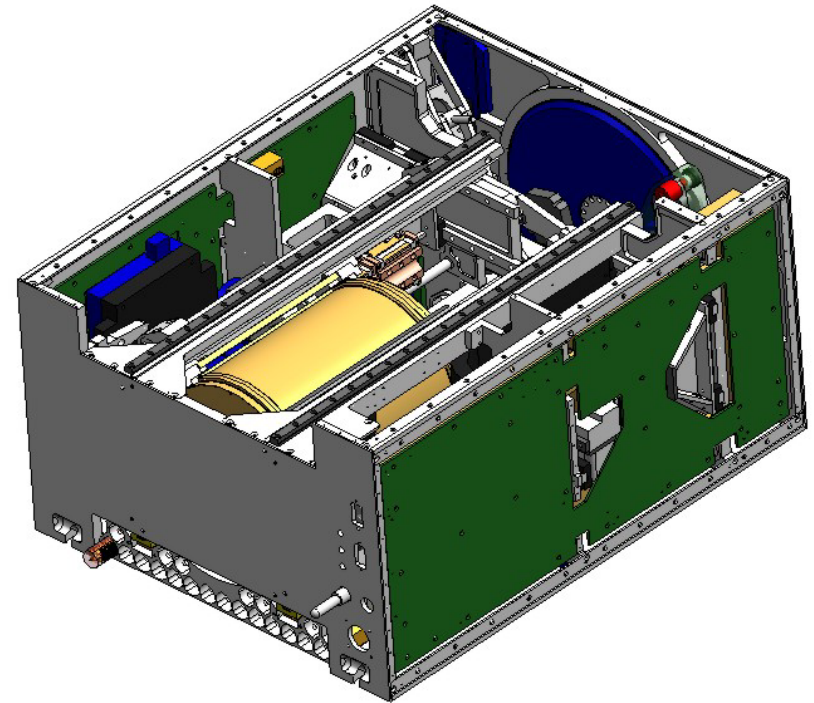
MVIS and ESA FSL

- In exchange for contribution, Canada will have access to 5% of ESA's fluid science laboratory
- 4 experimental containers in Phase A
 - Convection and interfacial mass exchange
Emulsions and aqueous foams
 - Fluid motion in spherical gaps



ATEN Furnace

- Multi-purpose
- Automated
- Compact
- Easy access to ground units
- Tele-operated
- Low vibration environment





Status of Other Payloads

■ **PROSPECT:**

- Phase 0/A completed:
- Phase B/C and D to start in FY 04/05

■ **MIMBU:** on hold

■ **SURF** Fluid facility: Phase A planned for FY 06/07





Space Life Sciences

- Life Science within the CSA is performed within the Space Science Program
- Space Medicine within the CSA is the responsibility of the Canadian Astronaut Office
- No in-house research





SLS Program Objectives

- Understand how life adapts, responds and functions in a space environment
 - Develop basic knowledge to support human spaceflight
 - Use the space environment to examine questions of importance on Earth
- Areas of focus selected in consultation with the Space Life Sciences Advisory Committee



Program Emphasis

- Bone and Muscle loss

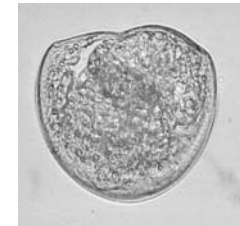
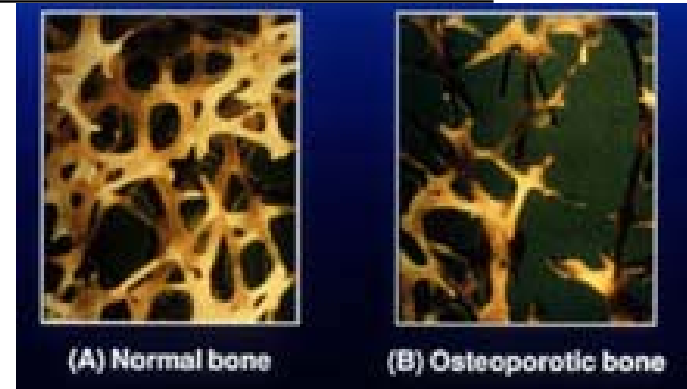
- Neuroscience

- Radiation biology and dosimetry

- Development

- Cardiovascular Physiology and Metabolism

- Multi- Cultural and Isolation Psychology



Recent SLS missions

■ H-reflex

- Looked at changes to spinal cord excitability in space
- In collaboration with NASA
- First medical experiment completed on ISS
- Had both shuttle and ISS component



Recent SLS missions

- **EVARM** (Extravehicular Radiation Monitoring)
 - Measured the radiation doses to the skin, eye and BFO of astronauts during EVA
 - To relate dose to factors in the EVA environment e.g. shielding, orbital position, solar activity
 - In collaboration with NASA



OSTEO-2

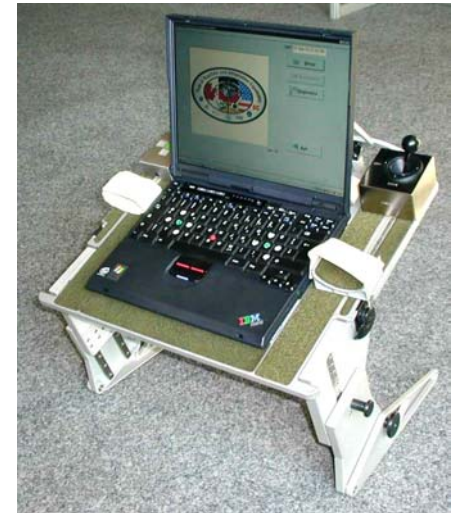
- 3 Separate experiments onboard shuttle that looked at different features of bone loss in microgravity
 - Lost onboard STS-107
- Also lost tissue-sharing experiment



SLS Missions Planned

■ PMDIS-TRAC

- Joint CSA-DLR venture
- PMDIS is shuttle experiment looking at causes of the short-term perception-motor deficits seen when first going into space
- TRAC is a station experiment
- Scheduled for STS-115





SLS Missions planned

■ **Cardiobeat**

- Looking at cardiovascular adaptation in microgravity and orthostatic intolerance

■ **CHENSS**

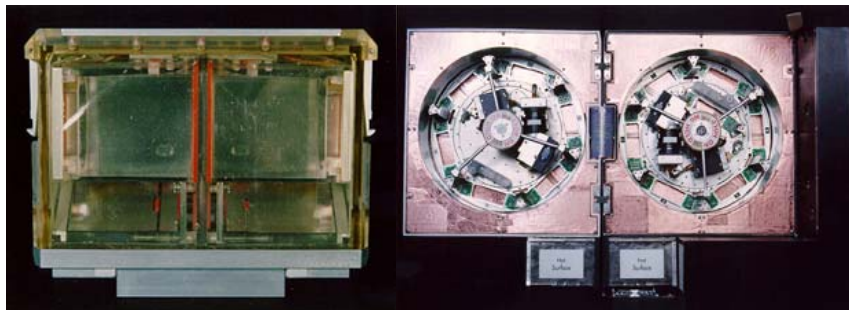
- Radiation monitor of space environment



International Hardware



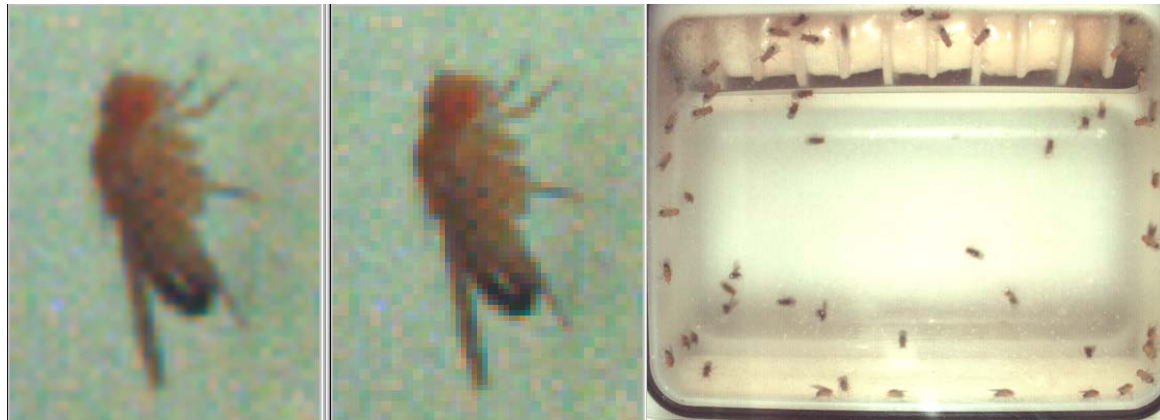
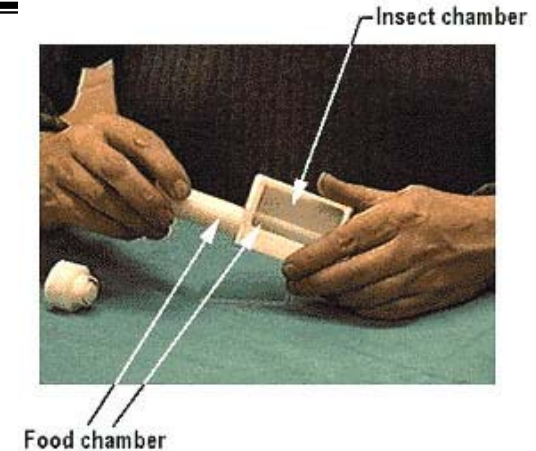
- Aquatic Research Facility (ARF)
 - Can control temperature, light (white and infrared), and have 1 g control in space
 - Completely automated
 - Fixation capability
 - Video capability
 - Successful flown



International Hardware

■ Insect Habitat

- Based on ARF technology
- will allow up to 6 generations
- very high quality video
- allows study of neural development, radiation sensitivity, behavior



Future opportunities

- Difficult to address
- Model organisms
 - *C. elegans*
 - *Arabidopsis*

International Approach

- Life Science and Microgravity Science have developed an international research approach
 - International Space Life Sciences Working Group (ISLSWG)
 - International Microgravity Sciences Working Group (IMSWG)
- Collaborative research is seen as positive, even essential
- Not restricted to ISS

International Approach for ISS



- Hardware sharing
 - Reduce/eliminate duplication
 - Outcome equal to or greater than that expected from individual participation
- Joint solicitation and review
- Joint implementation
 - each agency is responsible for implementation of their own HW





International Approach

Other projects:

- Joint ground/bedrest studies
- Joint integration of shuttle payloads
- Joint integration of recoverable satellite payloads
- Coordination of “current status” workshops
- **Model Organisms**

